Add New 90-115

CLAIMS:

1. A method for developing in living bone a bore that is defined by a bore wall with high-density bone tissue at a region of said wall that is adjacent to an exterior surface of said bone, said method comprising the steps of:

developing a pilot hole through said exterior surface and into said living bone, said pilot hole being defined by a first wall;

providing an elongated tool having a central axis, a lower end, an upper end and an engaging surface between said lower and upper ends, said tool having a generally circular cross-section taken perpendicular to said central axis, said cross-section having an area that decreases from said upper end to said lower end, said lower end being dimensioned for insertion into said pilot hole;

providing a driving mechanism capable of providing movement to said tool;

coupling said driving mechanism to said upper end of said tool;

inserting said lower end of said tool into said pilot hole;

activating said movement of said driving mechanism;

moving said upper end of said tool toward said pilot hole so that said engaging surface of said tool forces said first wall radially outward with respect to said central axis of said tool to create said bore wall with said high-density bone tissue at said region of said wall that is adjacent to said exterior surface; and

extracting said tool from said bore with generally no effect on the bone density at said region of said bore wall adjacent to said exterior surface.

2. The method of claim 1 wherein said movement from said driving mechanism imparted to said tool is longitudinal movement along said central axis of said tool and said step of moving said upper end of said tool toward said pilot hole is accomplished through said longitudinal movement.

3. The method of claim 1 wherein said movement from said driving mechanism imparted to said tool is vibrational movement and said step of moving said upper end of said tool is accomplished through movement provided by a clinician.

4. The method of claim 1 wherein said cross-section of said tool expands rapidly between said lower and upper ends at a transition region, said transition region forcing said first wall radially outward.

5. The method of claim 1 wherein said cross-section of said tool expands gradually between said lower and upper ends.

6. The method of claim 1, further including the steps of:

providing a second elongated tool having a central axis, a bottom end, a top end and an engaging surface between said top and bottom ends, said second tool having a generally circular cross-section taken perpendicular to said central axis that decreases from said top end to said bottom end, said bottom end having a cross-sectional area that is approximately no larger than said upper end of said first elongated tool;

coupling said driving mechanism to said top end of said second tool;

inserting said bottom end of said second tool into said bore;

initiating said movement of said driving mechanism;

moving said top end of said second tool toward said pilot hole so that said engaging surface of said second tool further creates said high-density bore wall; and

extracting said second tool from said bore with generally no effect on the bone density at said region of said bore adjacent to said exterior surface.

7. The method of claim 6 wherein said cross-section of said first tool expands rapidly between said lower and upper ends at a transition region, said transition region forcing said first wall radially outward, said cross-section of said second tool expands gradually between said top and bottom ends.

8. The method of claim 1 further including the step of removing a portion of said bone tissue at said first wall and displacing said bone tissue in a direction away from said exterior surface of said bone.

9. The method of claim 8 wherein said lower end of said tool is dimensioned to be slightly larger than said pilot hole and said tool includes a section for gathering said bone tissue to be displaced.

10. A method for developing in living bone a bore defined by a bore wall with high-density bone tissue along a substantial portion of a length of said bore wall, said living

bone having an internal wall defining an initial hole at the site where said bore is to placed, said method comprising the steps of:

providing an elongated tool having a central axis, a lower end, an upper end and an engaging surface between said lower and upper ends, said engaging surface having a sequence of regions from said lower end to said upper end that increase in cross-sectional area;

providing a driving mechanism capable of providing longitudinal movement;

coupling said driving mechanism to said upper end of said tool such that said longitudinal movement is substantially in the direction of said central axis of said tool;

inserting said lower end of said tool into said initial hole;

activating said longitudinal movement of said driving mechanism to move said upper end of said tool toward said initial hole so that sections of said internal wall of said initial hole is progressively acted upon by said sequence of regions of increased cross-sectional area to create said high-density bone tissue along said substantial portion of said length of said bore wall; and

extracting said tool from said bore wall.

11. The method of claim 10 wherein said step of extracting said tool removes only an insubstantial amount of bone tissue from said bore.

12. The method of claim 10 wherein said step of extracting said tool insubstantially affects said high-density bone tissue of said bore wall.

13. The method of claim 10 wherein said step of activating said longitudinal movement includes the step of removing a portion of the bone tissue on said internal wall with said tool and displacing said portion in a direction away from an opening of said bore.

14. The method of claim 10 wherein said tool tapers gradually to provide said sequence of regions on said engaging surface.

15. The method of claim 10 wherein said tool expands in cross-section rapidly between said lower and upper ends at a transition region, portions of said engaging surface on either side of said transition region and said transition region providing said sequence of regions on said engaging surface.

16. The method of claim 10 wherein said initial hole is created by another tool.

17. The method of claim 16 wherein said another tool is a compaction tool similar to said elongated tool.

18. The method of claim 10 wherein said bore is to be developed in a jawbone, said internal wall is a lower-density Type III or Type IV bone tissue and said high-density bone tissue is comparable to Type I or Type II bone tissue.

19. A method for developing in living bone a bore defined by a bore wall with high-density bone tissue along a substantial portion of a length of said bore wall, said living bone having an internal wall defining an initial hole at the site where said bore is to be placed, said method comprising the steps of:

providing an elongated tool having a central axis, a lower end, an upper end and an engaging surface between said lower and upper ends, said engaging surface having a sequence of regions from said lower end to said upper end that increase in cross-sectional area;

providing a driving mechanism capable of providing vibrational movement;

coupling said driving mechanism to said upper end of said tool;

inserting said lower end of said tool into said initial hole;

actuating said vibrational movement of said driving mechanism;

moving said upper end of said tool toward said initial hole so that said sequence of regions of said engaging surface progressively act upon and force said internal wall of said initial hole radially outward with respect to said central axis to create said high-density bone tissue along said substantial portion of said length of said bore wall; and

extracting said tool from said bore.

20. The method of claim 19 wherein said vibrational movement is substantially in the direction of said central axis of said tool.

21. The method of claim 19 wherein said steps of actuating said vibrational movement and moving said upper end of said tool occur simultaneously.

22. The method of claim 19 wherein said driving mechanism is further capable of providing longitudinal motion, said step of moving said upper end of said tool toward said initial hole is accomplished by said driving mechanism.

23. The method of claim 19 wherein said step of moving said upper end of said tool toward said initial hole is accomplished through manual exertion of force by a clinician.

24. The method of claim 19 wherein said initial hole is created by another tool.

25. The method of claim 19 wherein said step of extracting said tool removes only an insubstantial amount of bone from said bore.

26. The method of claim 19 further including the step of removing a portion of the bone tissue from said internal wall of said initial bore and displacing said portion in a direction away from an opening of said bore.

27. The method of claim 19 wherein said tool tapers gradually to provide said sequence of regions on said engaging surface.

28. The method of claim 19 wherein said tool expands in cross-section rapidly between said lower and upper ends at a transition region, portions of said engaging surface on either side of said transition region and said transition region providing said sequence of regions on said engaging surface.

29. The method of claim 19 wherein said bore is to be developed in a jawbone, said internal wall is a lower-density Type III or Type IV bone tissue and said high-density bone tissue is comparable to Type I or Type II bone tissue.

30. A combination of a set of tools and a driving mechanism for creating in living bone a bore that is defined by a bore wall with high-density bone tissue, said set of tools for compacting bone tissue on said bore wall, said set including a plurality of tools each having a central axis, a lower end, an upper end and an engaging surface between said lower and upper ends, said tool having a generally circular cross-section taken perpendicular to said central axis, said cross-section having an area that decreases from said upper end to said lower end, said engaging surface being configured to maintain substantially all of said bone within said bore when said tool is extracted therefrom, said set of tools including at least one tool having a larger cross-sectional area adjacent to said lower end than said remaining ones of said set of tools; and

said driving mechanism including means for interchangeably coupling said driving mechanism to said upper end of a selected tool of said set of tools, said driving mechanism

further including means for providing longitudinal movement to said selected tool of said set of tools.

31. The combination of claim 30 wherein said coupling means includes means for quickly releasing and attaching said selected one of said set of tools from said driving mechanism.

32. The combination of claim 31 wherein said coupling means includes a spring element.

33. The combination of claim 31 wherein said coupling means includes a pin element extending into said tool.

34. The combination of claim 30 wherein said longitudinal movement providing means includes a cam element.

35. The combination of claim 30 wherein said longitudinal movement providing means includes a pair of meshing gears.

36. The combination of claim 30 wherein said longitudinal movement providing means includes a solenoid.

37. The combination of claim 30 wherein said longitudinal movement providing means includes a piezoelectric element.

38. The combination of claim 30 wherein said set of tools includes at least one tool that expands rapidly between said lower and upper ends at a transition region.

39. The combination of claim 30 wherein each of said set of tools includes marking means positioned a common distances from said lower end.

40. The combination of claim 39 wherein said marking means includes a groove.

41. The combination of claim 39 wherein said marking means includes a ring positioned around said tool.

42. The combination of claim 30 wherein at least one of said tools includes an inwardly concave lower end.

43. The combination of claim 30 wherein at least one of said tools includes an outwardly convex lower end.

44. A combination of a set of tools and a driving mechanism for creating in living bone a bore defined by a bore wall that has high-density bone tissue, said set of tools for compacting bone tissue on said bore wall, said set including a plurality of tools each having a central axis, a lower end, an upper end and an engaging surface between said lower and upper ends, said engaging surface having a sequence of regions from said lower end to said upper end that increase in cross-sectional area, said engaging surface being configured to maintain substantially all of said bone within said bore when said tool is extracted therefrom, said set of tools including at least one tool having a larger cross-sectional area adjacent to said lower end than said remaining ones of said set of tools; and

said driving mechanism including means for interchangeably coupling said driving mechanism to said upper end of a selected tool of said set of tools, said driving mechanism further including means for providing vibrational movement to said selected tool of said set of tools.

45. The combination of claim 44 wherein said vibrational movement is primarily in the direction of said central axis of said tool.

46. The combination of claim 44 wherein said tool tapers gradually to provide said sequence of regions on said engaging surface.

47. The combination of claim 44 wherein said tool expands in cross-section rapidly between said lower and upper ends at a transition region, portions of said engaging surface on either side of said transition region and said transition region providing said sequence of regions on said engaging surface.

48. The combination of claim 44 further including a structure that allows the clinician to grasp to manually push said tool into said bore.

49. The combination of claim 44 wherein said vibrational movement providing means includes a piezoelectric element.

50. A combination of a set of tools and a driving mechanism for creating in living bone a bore that has high-density bone tissue, said set of tools including a plurality of tools each having a central axis, a lower end, and an upper end, each of said set of tools having a cutting edge exclusively at said lower end, said set of tools including at least one

tool having a larger cross-sectional area adjacent to said lower end than said remaining ones of said set of tools; and

said driving mechanism including means for interchangeably coupling said driving mechanism to said upper end of a selected tool of said set of tools, said driving mechanism further including means for moving said selected tool of said set of tools.

51. The combination of claim 50 wherein said moving means provides vibrational movement.

52. The combination of claim 50 wherein said moving means provides longitudinal movement.

53. The combination of claim 50 wherein each of said tools includes means for transferring bone tissue from regions in said bore near an exterior surface of said bone to deeper regions of said bore.

54. The combination of claim 53 wherein said transferring means is a concave face at said lower end of said tool.

55. The combination of claim 54 wherein cutting surface is defined by the interface of said concave face and said engaging surface at said lower end.

56. The combination of claim 50 wherein said set of tools includes a tool for making a small-diameter pilot hole, one of said set of tools having a diameter at said lower end that is slightly larger than said pilot hole.

57. A combination of a set of tools and a driving mechanism for creating in living bone a bore that defined by a bore wall having high-density bone tissue, said set including a plurality of tools each having a central axis, a lower end, an upper end and a bone-engaging surface between said lower and upper ends, said bone-engaging surface for compacting bone tissue on said bore wall to create said high-density bone tissue; and

said driving mechanism including means for interchangeably coupling said driving mechanism to said upper end of a selected tool of said set of tools, said driving mechanism further including means for imparting non-rotational movement to said selected tool of said set of tools.

58. The combination of claim 57 wherein said movement imparting means provides primarily vibrational movement.

59. The combination of claim 57 wherein said movement imparting means provides primarily longitudinal movement.

60. The combination of claim 57 wherein said bone-engaging surface extends substantially the entire distance between said lower and upper surfaces.

61. A method for transferring bone tissue from a section of a bore to a deposit region of said bore, said bore being defined by a bore wall, said method comprising the steps of:

providing an elongated tool having a lower end, an upper end, a cutting edge adjacent to said lower end, and a gathering section adjacent to said cutting edge for receiving said bone tissue to be transferred;

providing a driving mechanism capable of providing movement to said tool;

coupling said driving mechanism to said upper end of said tool;

inserting said lower end of said tool into said bore;

moving said upper end of said tool said bore so that said cutting edge of said tool removes said bone tissue from said bore wall while said driving mechanism is providing said movement to said tool;

collecting said removed bone tissue in said gathering section;

continuing moving said tool into said bore;

depositing said removed bone tissue at said deposit region of said bore; and

extracting said tool from said bore after said gathering section has reached said deposit region of said bore.

62. The method of claim 61 wherein said step of moving said upper end of said tool is accomplished through movement provided by a clinician, said movement provided by said driving mechanism being primarily vibrational movement.

63. The method of claim 61 wherein said movement is primarily longitudinal movement and said step of moving said upper end of said tool is accomplished through said longitudinal movement provided by said driving mechanism.

64. The method of claim 61 wherein said gathering section is an inwardly concave face at said lower end.

65. The method claim 64 wherein said cutting edge is exclusively at a lowermost portion of said lower end.

66. The method of claim 61 wherein said depositing region is located at the deepest region of said bore.

67. The method of claim 61 further including the step of compacting bone tissue on said bore wall with a bone-engaging surface between said upper and lower ends.

68. The method of claim 67 wherein said bore is to be inserted in a jawbone and said step of compacting results in a high-density bore wall of Type I or Type II bone tissue.

69. A system for creating in living bone a bore that defined by a bore wall having high-density bone tissue, said system comprising:

a tool having a central axis, a lower end, an upper end and a bone-engaging surface between said lower and upper ends, said bone-engaging surface for compacting bone tissue on said bore wall to create said high-density bone tissue;

a driving mechanism including means for interchangeably coupling said driving mechanism to said upper end of said tool, said driving mechanism imparting movement to said tool;

means for sensing a characteristic of said tool, said sensing means producing signals; and

a controller coupled to said driving mechanism and said sensing means, said controller controlling the operation of said driving mechanism in response to said signals received from said sensing means.

70. The system of claim 69 wherein said movement is primarily vibrational movement.

71. The system of claim 69 wherein said movement is primarily longitudinal movement.

72. The system of claim 69 wherein said characteristic is a movement characteristic of said tool and said sensing means is a movement sensor.

73. The system of claim 69 wherein said characteristic is a positional characteristic of said tool and said sensing means is a position sensor.

74. The system of claim 69 wherein said sensing means is mounted on said tool.

75. The system of claim 69 wherein said sensing means is mounted on said driving mechanism.

76. The system of claim 69 wherein said sensing means is mounted externally to said tool and said driving mechanism.

77. The system of claim 69 further including means for inputting operational characteristics of said tool by said clinician, said inputting means being coupled to said controller.

78. The system of claim 69 wherein said characteristic is operational frequency.

79. The system of claim 69 wherein said characteristic is operational amplitude.

80. A combination of a set of tools and a driving mechanism for creating in living bone a bore that has high-density bone tissue, said set of tools including a plurality of tools each having a central axis, a lower end, and an upper end, each of said set of tools including means for delivering a material to a region of said bore, said set of tools including at least one tool having a larger cross-sectional area adjacent to said lower end than said remaining ones of said set of tools; and

said driving mechanism including means for interchangeably coupling said driving mechanism to said upper end of a selected tool of said set of tools, said driving mechanism further including means for moving said selected tool of said set of tools.

81. The combination of claim 80 wherein said delivering means includes an internal channel within said tool.

82. The combination of claim 80 wherein said delivering means includes an opening on an exterior surface of said tool.

83. The combination of claim 80 wherein said delivering means includes a pumping source to convey said material to said tool.

84. The combination of claim 80 wherein said material is an osseointegration enhancing materials.

85. The combination of claim 80 wherein said material is a lubricating material.

86. A combination of a compaction tool and a driving mechanism for creating in living bone a bore that has high-density bone tissue, said compaction tool having a central axis, a lower end, an upper end, and an engaging surface between said lower end and said upper end, said engaging surface for displacing bone tissue that is initially in the area defined by said bore primarily in the radial direction to said central axis; and

said driving mechanism including means for interchangeably coupling said driving mechanism to said upper end of said tool, said driving mechanism further including means for moving said tool.

87. The combination of claim 86 wherein said moving means provides vibrational movement.

88. The combination of claim 86 wherein said moving means provides longitudinal movement.

89. The combination of claim 86 wherein said combination is for use in a jawbone and said engaging surface is configured to compact lower-density Type III or Type IV bone tissue to Type I or Type II bone tissue.

Add B1